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(54) System for the assembly of a metal joining-piece and a high-pressure composite material tube - notably applications for equipment used in the oil industry.

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EP-A- 0 132 067
DE-A- 2 064 504
GB-A- 2 009 875
US-A- 2 219 047
US-A- 3 551 671
US-A- 4 313 629
AT-B- 320 362
DE-U- 1 932 448
GB-A- 2 059 581
US-A- 2 854 030
US-A- 4 180 735

INTERNATIONAL JOURNAL OF APPLIED RADIATION AND ISOTOPES, vol. 34, no.1, January 1983, pages 309-331, Oxford, GB; J.S. WATT: "On-Stream analysis of metalliferous ore slurries", page 327; figure 21

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Description

This invention concerns an assembly system of composite material and metal, making use of composite materials for transportation of corrosive and/or abrasive fluids possible at static pressures of up to 150 MPa.

An assembly of a composite material part and a metal part is known e.g from DE-U-1932448.

In particular, the invention facilitates insertion between metal tubes (through which a fluid under very high pressure is flowing) of a composite tube element which may be part of a sensor designed to measure various properties of the fluid (viscosity, flow-rate, density, etc.)

One of the problems recognised in the previous state of the art was the difficulty of realising composite material/metal joints able to withstand very high pressures for long periods of time. The invention solves this problem.

One most important application is to sensors used in oil and oil-related industry, used, as is well-known, to measure the properties (viscosity, density, rheology, etc.) of fluids piped under very high pressure, which may be corrosive (acids) and/or highly abrasive (cement slurries).

Using the invention, a metal joining-piece with a projecting collar at the end in contact with the composite material and a high pressure joining element at the other end is placed between the composite material and the metal tube.

Figures 1 and 2 show a non-limitative, preferred method for realisation of the joint in longitudinal section of depicting a plane parallel to the tube axis.

One of the essential features is the projecting collar (2) around which the various layers of composite material are placed in the accustomed manner, by winding.

The advantage of this structure is that normal winding of the composite material is made possible while resistance to tensile and torsional stresses occurring between a metal tube and the metal joining-piece on one hand, and the composite tube on the other, is ensured.

Thus, risk of distortion, leaks and fractures, which are common in attempts made in the previous state of the art, is eliminated.

Considering the working pressures, it is evident that this advantage is quite decisive.

Within oil and oil-related industry, the drawbacks of the previous state of the art have even more serious consequences (any interruption of work on a line involves serious risks : bad well treatment, bad cement placement ; with sometimes unsalvagable consequences).

References are as follows :

1 . Wound composite material
2 . Collar on metal joining-piece
3 . Metal joining-piece
4 . Circumferential fibres of the composite material
5 . Longitudinal fibres of the composite material
P . Pressure exerted by the pump fluid inside the tube
S . Tube section
F . Forces of longitudinal tension due to pressure
R . Radius of collar
AB . Angles of the oblique planes of the collar
6 . Anti-abrasion/anti-corrosion sleeve
7 . "Weco" type assembly system with a high-pressure metal tube not shown
8 . High-pressure seal
9 . Protective ring
10 . O-rings

Figure 3 shows a very high pressure tube of composite material which can be joined at both ends using the invention.

Figure 1 shows the working principle of the invention in detail.

When a very high pressure P is applied inside the tube, it creates a strong tensile force F = PxS within the material constituting the tube.

The longitudinal fibres (5) of the composite material partially absorb this force. In the joint zone of the composite tube and the metal joining-piece (3), shearing forces at the interface of the two materials reach values such that no adhesive suffices to keep the assembly together.

It is in this context that the assemblies of the previous state of the art are fragile. Using the invention discussed here, the composite material tube is wound around projecting collar (2) on the metal joining-piece.

When a pulling force is exerted on the tube, any slippage should be absorbed by the increase in diameter of some of the turns in the layer of circumferential fibres (4) in the composite material.

These fibres consist of a material with very high Young's modulus, as is notably the case in glass, carbon or aramid fibres. It is therefore very difficult, if not impossible, to cause the assembly to slip, whether by pulling apart or by compressing. This is due to the shape of the collar (2) which has two oblique planes with angles A and B.

To avoid breaking the longitudinal fibres by incipient fracture, care will be taken to select appropriate radii R for the collar.

Collar profile may be chosen in various ways, but it should preferably have a shape which causes diameter changes to be as "gentle" as possible.

In another method of winding, composite material fibres are wound in two symmetrical spirals (one left-handed, the other right-handed), with the fibre angle, measured in relation to the tube axis, being from 50 to 60. It is well-known that a tube consisting of spirally wound fibres wound at an

angle of approximately Arc tan (2), 54.73 , is practically unexpandable through the effect of pressure forces.

Finally, it is possible to envisage the configuration of the invention as a combination of more than 2 layers of fibres with winding angles selected from the examples given.

Figure 2 is a drawing of the invention. A sleeve 6, made of a material (notably polyurethane or polytetrafluorethylene) which is resistant to (corrosive or abrasive) fluids pumped, protects the composite material form chemical attack. In fact, it is known that resins linking the material's reinforcing fibres can be dissolved by certain fluids and that glass fibres are attacked by hydrofluoric acid.

The sleeve 6 can be used advantageously when manufacturing the tube. It can be used as a guide when winding the composite material over the metal joining-piece 2.

The metal part 9 attached to the seal 8 enables the end of the sleeve 6 to be protected against abrasion. The O-rings 10 provide a complete seal, so preventing penetration of aggressive fluids between part 9 and the sleeve 6, through the effect of pressure.

In this example, the end 7 of a "Weco" type female high-pressure joint has been depicted. The WECO assembly system is well-known, especially in oil and oil-related industry. It could, however, be replaced by any other system, known to those skilled in the art, which would be capable of resisting the very high pressures mentioned here.

Finally, figure 3 shows a very high pressure pipe with a male and female (respectively) "Weco" type joint at each end, joined to the composite material tube using the invention.

The interest of using polymer-based composite materials for high-pressure lines lies above all in the great weight-saving, which makes for easier handling and the possibility of carrying a larger number of pipes per lorry. For industry, notably oil and oil-related industry, this advantage is of utmost importance, especially in the oilfield and offshore.

One particularly interesting application is the non-intrusive measurement of the density of a fluid travelling through a tube.

The invention discussed here uses a tube of composite material as part of the standard density measurement device. This material has the property of absorbing considerably less of the radiation in question than steels and, more generally, metals, which makes it possible to considerably reduce the radiation source activity while retaining an identical detection. Consequently, protective shielding round the source and so the weight and size of the assembly are also reduced. The above-mentioned properties of composite materials have been known for around ten years. However, it has not, in that time, seemed possible to use them within the field of very high pressure devices using a permanent radiation source. Also, the industry did not have any reliable means of making metal/composite joints capable of resisting these very high pressures. This includes oil field applications. Experiment has shown that, in fact, use of these materials is compatible with the application envisaged, particularly as a result of the assemblies described above.

Of course, application of the invention is not limited to the oil industry, and covers other known fields in which radiation densimeters, as well as other sensors such as flow meters, etc., are used. The invention is sure to be of great usefulness in all fields in which a tubular element (sensor, etc.) is applied to a tubular metal line, and where the composite material construction of the tubular element affords great advantage (the choice of composite material having previously been impossible due to the absence of suitable metal/composite joints, especially in high pressure applications).

Claims

1. Assembly system of a composite material cylindrically symmetrical part and a metal part, capable of resisting very high internal pressures of up to 150 MPa, wherein the end (1) of the composite material part at least partially encloses and covers a cylindrical-symmetrical metal joining-piece (3) featuring a collar (2) of the same internal diameter at one end, the section of which has a substantially trapezoidal shape (2) in the plane of the axis of symmetry, around which the reinforcing fibres of the composite material are "wound" ; and the composite material in the area of metal interface with the metal joining-piece (3) consists of at least one longitudinal layer (5) of reinforcing fibres, lying in a direction parallel to the axis and at least one circumferential layer (4) of reinforcing fibres, wound in substantially circular turns placed in directions essentially perpendicular to the system's axis of symmetry.

2. System in accordance with claim 1 characterised in that the inside wall of the composite material tube is fitted with a tube (6) which protects the composite material from any aggressive fluids which may be pumped through the tube, particularly acids and abrasive fluids.

3. System in accordance with claim 2, characterised in that the protective tube is of a polyurethane, polytetrafluorethylene or analogous material.

4. System in accordance with claims 1 to 3, characterised in that the composite material consists of a fibre-linking resin and of reinforcing fibres which may be glass, carbon, aramid, or analogous fibres.

5. Application of a system according to any one of claims 1 to 4 to very high pressure sensors for up to 150 MPa of internal pressure.

Revendications

1. Système d'assemblage d'une pièce cylindriquement symétrique en matière composite et d'une pièce métallique, susceptible de résister à des pressions internes très élevées allant jusqu'à 150 MPa, dans lequel l'extrémité (1) de la partie en matière composite enferme au moins partiellement et recouvre un élément métallique de jonction (3) cylindriquement symétrique présentant à une extrémité un collier (2), de même diamètre intérieur, dont la section transversale est d'une forme sensiblement trapézoïdale (2) dans le plan de l'axe de symétrie, autour duquel les fibres d'armature de la matière composite sont "enroulées", et la matière composite dans la zone de l'interface avec l'élément métallique de jonction (3) consiste en au moins une couche longitudinale (5) de fibres d'armature, reposant dans une direction parallèle à l'axe et au moins une couche circonférentielle (4) de fibres d'armature enroulées selon des tours sensiblement circulaires placés dans des directions essentiellement perpendiculaires à l'axe de symétrie du système.

2. Système selon la revendication 1, caractérisé en ce que la paroi intérieure du tube en matière composite est équipée d'un tube coaxial (6) qui protège la matière composite de tous fluides agressifs qui pourraient être pompés à travers le tube, en particulier des fluides acides et abrasifs.

3. Système selon la revendication 2, caractérisé en ce que le tube protecteur est en polyuréthanne, en polytétrafluoréthylène ou en matière analogue.

4. Système selon les revendications 1 à 3, caractérisé en ce que la matière composite consiste en une résine de liaison des fibres et en fibres d'armature qui peuvent être en verre, en carbone, en aramide ou en fibres analogues.

5. Application d'un système selon l'une quelconque des revendications 1 à 4 à des capteurs à très haute pression (pouvant atteindre 150 MPa de pression interne).

Patentansprüche

1. System zur Verbindung eines zylindersymmetrischen Verbundmaterialteils mit einem Metallteil, welches System sehr hohen Innendrücken bis zu 150 MPa standhalten kann, wobei das Ende (1) des Verbundmaterialteils ein zylindersymmetrisches Metallverbindungsstück (3) wenigstens teilweise umschließt und bedeckt,
wobei das Metallverbindungsstück (3) an einem Ende einen Kragen (2) gleichen Innendurchmessers aufweist,
wobei ein Schnitt durch den Kragen in einer die Symmetrieachse enthaltenden Ebene eine im wesentlichen trapezförmige Gestalt hat,
wobei Verstärkungsfasern des Verbundmaterials den Kragen umschlingen und
wobei das Verbundmaterial in seinem Anlagebereich an dem Metallverbindungsstück (3) aus wenigstens einer Längsschicht (5) von Verstärkungsfasern besteht, die in einer zu der Symmetrieachse parallelen Richtung verlaufen, und wenigstens eine Umfangsschicht (4) von Verstärkungsfasern aufweist, die in im wesentlichen kreisförmigen, im wesentlichen rechtwinklig zu der Symmetrieachse des Systems liegenden Windungen verlaufen.

2. System nach Anspruch 1, dadurch gekennzeichnet, daß in die Innenfläche eines Rohrs aus dem Verbundmaterial koaxial ein Rohr (6) eingepaßt ist, das das Verbundmaterial vor aggressiven Fluiden, insbesondere Säuren und abrasiven Fluiden, schützt, die durch das Rohr gepumpt werden können.

3. System nach Anspruch 2, dadurch gekennzeichnet, daß schützende Rohr aus Polyurethan, Polytetrafluorethylen oder analogem Material besteht.

4. System nach Anspruch 1 bis 3, dadurch gekennzeichnet, daß das Verbundmaterial aus einem faserverbindenden Harz und Verstärkungsfasern, wie z.B. Glas-, Kohlenstoff-, Aramidfasern oder analogen Fasern, besteht.

5. Anwendung eines Systems nach einem der Ansprüche 1 bis 4 bei Sensoren für sehr hohe Drücke bis zu 150 MPa Innendruck.

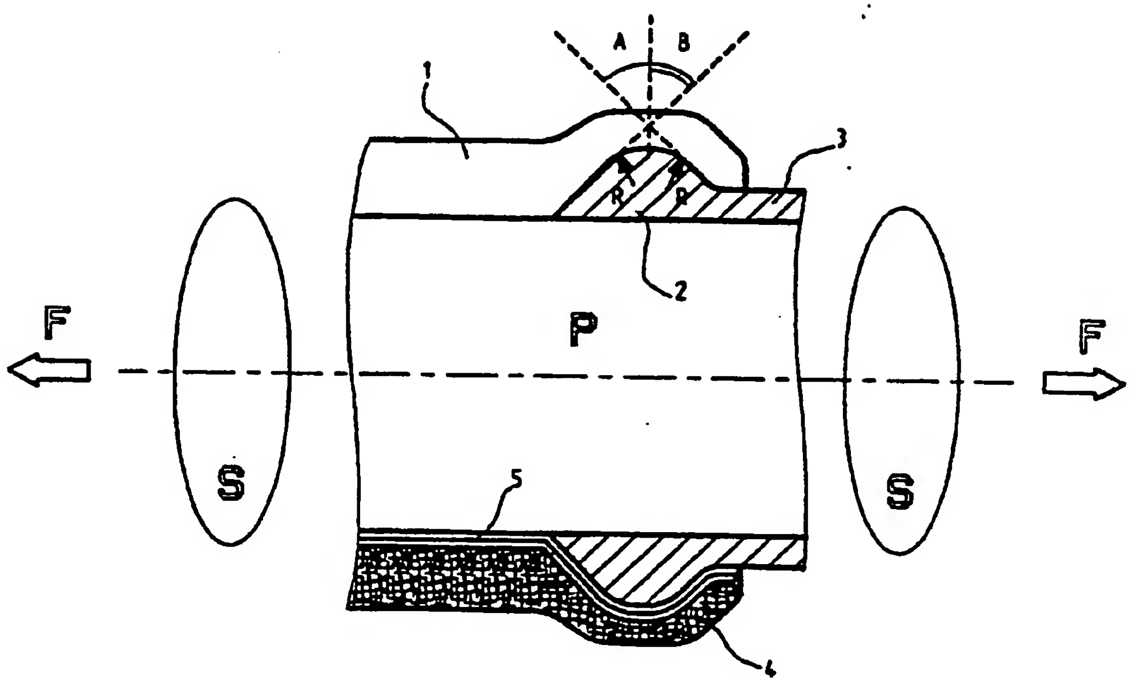

fig-1

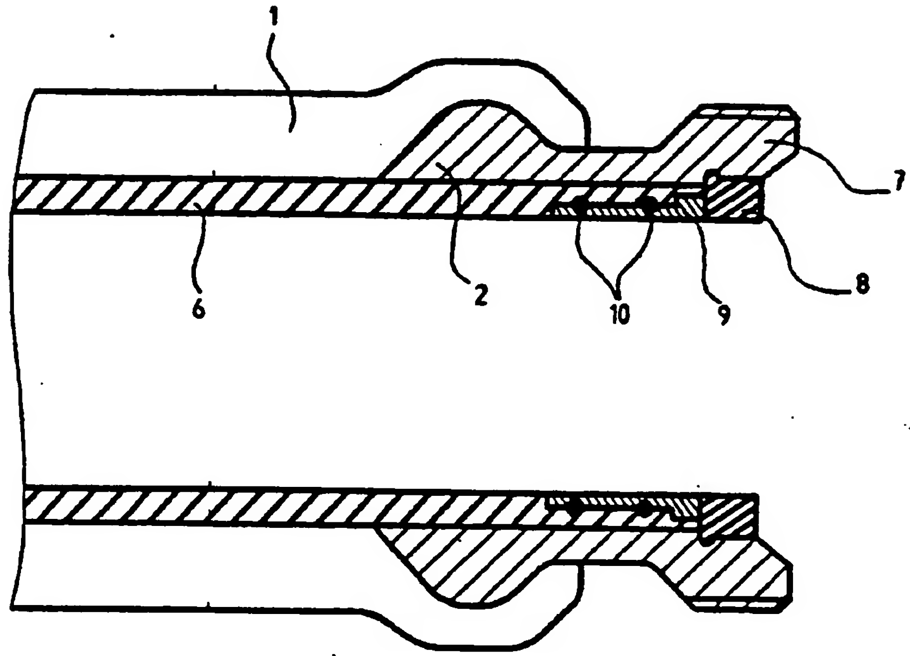

fig-2

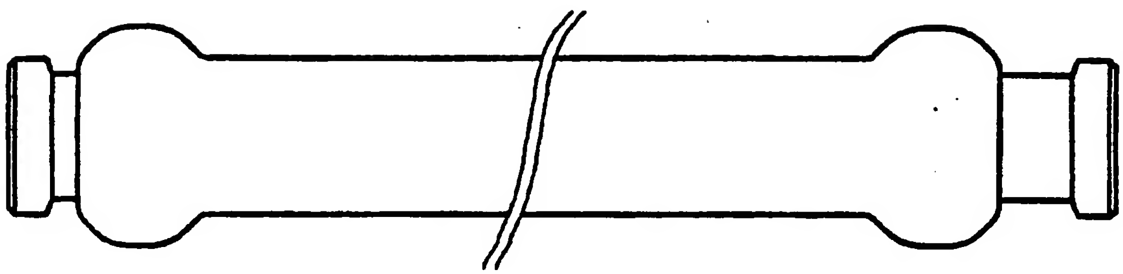

fig-3